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Information Technology Infrastructure for E-Business

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Title: **Information Technology Infrastructure for e-Business**

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Abstract: As firms migrate from their traditional physical business models to a combination of physical and e-business models, the importance of information, particularly customer information, raises the stakes for the management of the firm's information technology infrastructure. The number of opportunities for investing in IT infrastructure, however, can easily overwhelm senior management teams. To guide IT investment decisions this paper examines e-business IT infrastructure requirements. Based on a study of 50 e-business initiatives, the researchers classified e-business initiatives into 8 different atomic e-business models and then examined the need for each of 70 IT infrastructure services by each atomic model. The results indicate that each type of e-business model demands a different set of five or six key infrastructure services. This finding should help executives identify IT investment priorities for their e-business strategies. Recommendations are made for senior management to review their firm's IT governance to ensure IT infrastructure needs for e-business are identified early in the strategizing process.

22 Pages

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Information Technology Infrastructure for E-Business

Dot com, dot go: capitalizing on the E-Business Revolution

The rise and fall of the dot com has been a wake-up call to traditional businesses that are thinking about the power of their business models in an on-line world. Much of the focus of the media, academia, and Wall Street has been on the radical new business models being simultaneously developed and market tested by highly publicized start-up firms in this first wave of e-business. However, existing businesses will do much of the really hard work and make most of the profits in the second wave of e-business. E-business will require existing businesses to change—but not abandon everything that has made them successful. Traditional businesses must migrate from the physical to the e-business world. This migration includes making challenging leadership decisions about which e-business models will succeed and how they will integrate with current ways of serving the customer. Many of the assets (for example brand, cash, relationships, market share) of successful place-based businesses will serve equally well in e-business, but some liabilities are painfully apparent, including the lack of e-savvy leaders, corporate cultures resistant to change, reward systems incompatible with e-business, potential channel conflict, and non e-compatible information technology infrastructures.

We expect the second wave of e-business will have four important characteristics:

1. The difficulty of building and sustaining a profitable dot com business will be reflected in more realistic (i.e., lower) stock market valuations. We expect to see one or two successful dot coms in each major business sector, and the rest struggle to survive.

2. Existing firms will evolve to e-business models combining the best of the physical and electronic worlds. Existing firms will seriously challenge dot coms by providing higher-quality services more cheaply that are integrated with their place-based channels.

3. The artificial distinctions between B2B, B2C, and C2C will disappear. Many viable e-business models will serve a combination of business and household customers, representing different customer segments requiring different value propositions.

4. To compete in this e-business world, traditional firms will need to continue to invest heavily in IT infrastructure, which is the foundation of e-business.

Information Technology Infrastructure Capability

Information technology infrastructure is used in all e-business initiatives to connect different parts of the firm and link to suppliers, customers, and allies. Information technology infrastructure investments made by firms will be as critical for creating long-term shareholder value as the previous waves of physical infrastructure investments in property, plant, and equipment. In this section we first define information technology infrastructure and then present the findings of our recent study of 50 e-business initiatives and their infrastructure requirements.

This paper draws heavily on *Place to Space: Migrating to e-Business Models* by Peter Weill and Michael Vitale, to be published in April/May by Harvard Business School Press.

Our list of the 70 information technology infrastructure services needed for e-business is presented in the Appendix.

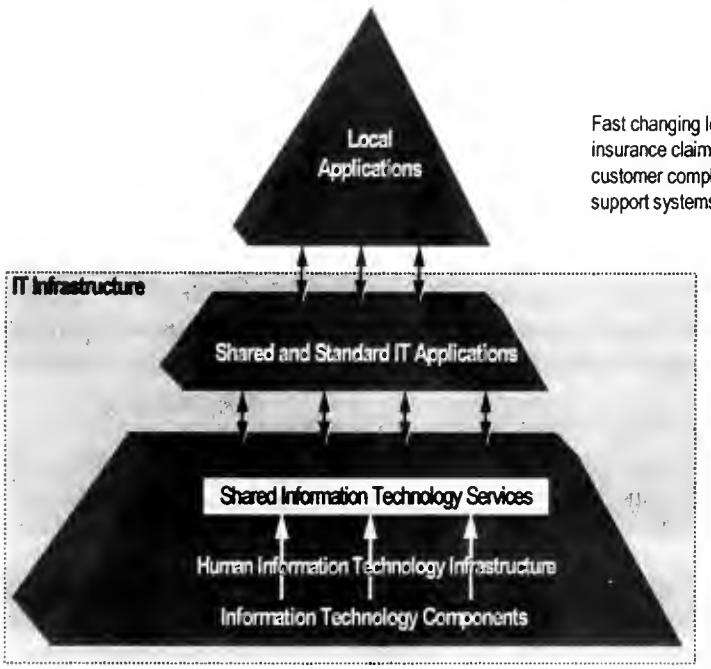
We define a firm's information technology portfolio as its total investment in computing and communications technology[i] (see Figure 1). The IT portfolio thus includes hardware, software, telecommunications, electronically stored data, devices to collect and represent that data, and the people who provide IT services. The portfolio includes both information technology capability provided by internal groups ("insourced") and those outsourced to suppliers such as IBM Global Services and EDS.

The foundation of the information technology portfolio is the firm's longer term information technology infrastructure, which in turn is linked to external industry-based infrastructures such as bank payments systems, airline reservations systems, and automotive industry supply chain networks, and to public infrastructures such as the Internet and telecommunications networks. The combination of the internal and external information technology infrastructures make up the firm's information technology infrastructure. The various elements of internal information technology infrastructure are presented in Figure 1, with the remaining parts of the portfolio referred to as "Local Applications." At the base of this framework are the technology components such as computers, printers, database software packages, operating systems, and scanners. These devices are commodities and readily available in the market place. The second layer is comprised of a set of shared information technology services. The technology components are converted into useful *shared services* by a human information technology infrastructure composed of knowledge, skills, standards, and experience. This human infrastructure binds the technology components into reliable services that form the firm's information technology infrastructure.

The services notion of information technology infrastructure is very powerful. The concept emerged from our discussions with business managers grappling with what they were actually getting for their information technology investments. Business managers told us they have great difficulty valuing technology components such as a server or a database package. New information technology staff appointments are also difficult to value. However, business managers can more readily value a service, such as the provision of a fully maintained personal computer with access to all of the firm's systems and the Internet. Such services can be specified, measured, and controlled in a service level agreement. Perhaps most importantly, managers can price services in the market place for comparison. Thinking of infrastructure as services places the internal consumer - the business manager - in charge, rather than the provider, whether the provider is the information systems group or an outsourcer. The service notion also provides more certainty to the provider as to their responsibilities, and allows for more precise planning.

Figure 1: The Structure of IT Infrastructure

The base foundation of budgeted-for IT capability (both technical and human), shared throughout the firm as reliable services, and centrally coordinated.



Fast changing local business applications such as: insurance claim processing, bank loan applications, customer complaints support system, phone order support systems.

Shared and standard applications which change less regularly such as accounting, budgeting, human resource management.

Services which are stable over time such as management of shared customer databases, PC/LAN access, intranet.

Human infrastructure of knowledge, skills, policies, standards and experience binds components.

Commodities such as: computers, printers, routers, database software, operating systems, credit card swipers.

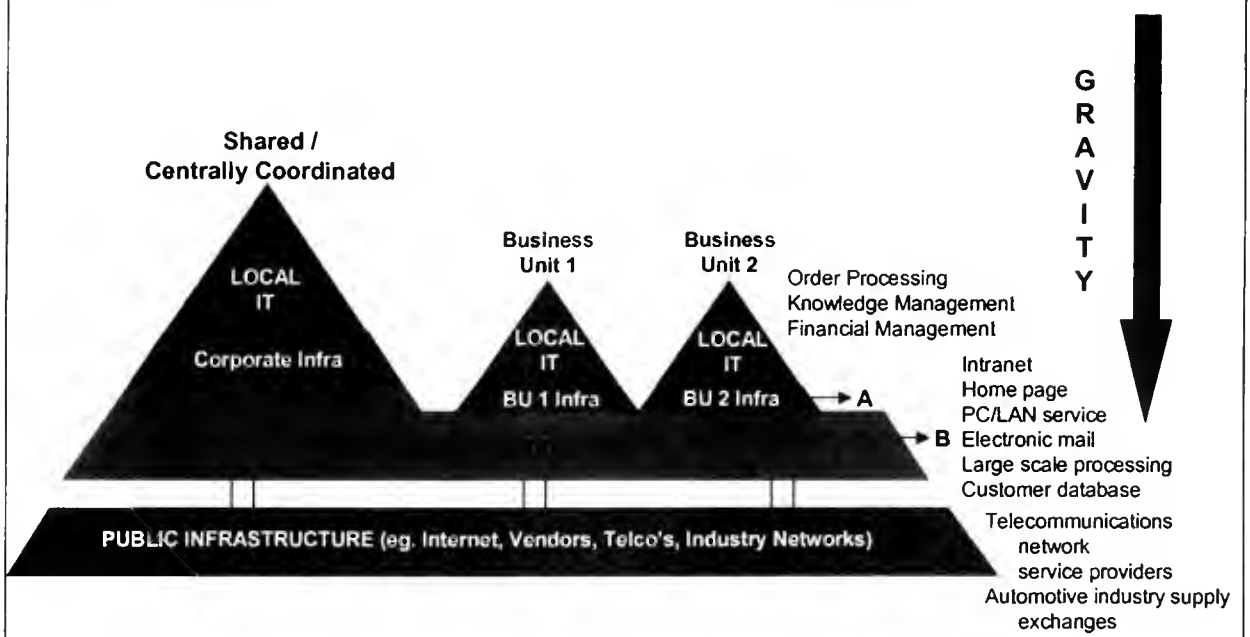
Source: Figure 4-1 P. Weill & M. Broadbent "Leveraging the New Infrastructure: How Market Leaders Capitalize on IT", Harvard Business School Press, June 1998.

The infrastructure services within a firm often include telecommunication network services, management and provision of large-scale computing (such as servers or mainframes), management of shared customer databases, research and development expertise aimed at identifying the usefulness of emerging technologies to the business, and a firm-wide intranet. An increasing number of firms have an additional layer of shared and standard infrastructure applications used by all business units. These often include firm-wide applications that support shared services in areas such as accounting, human resource management, and budgeting.

Historically, the set of infrastructure services required by a firm is relatively stable over time. Similar services are generally required from year to year, with gradual improvements in the componentry occurring over time to take advantage of new technologies and efficiencies. From time to time new services are required to support a new initiative. However, occasionally a major disruption occurs requiring a quantum leap in services required. Our research shows that e-business introduced the need for significantly more and different infrastructure services for most firms. It is likely that after a number of new services are created for e-business, the set of infrastructure services will again plateau. In contrast, the information technology required for business processes—particularly e-business applications—changes continually, often on a quarterly or even monthly basis as business processes are altered to better suit customer needs or in response to

competitor activity. In many firms, website functionality is increased every month. To understand how IT infrastructure needs may have changed as a result of e-business, we conducted a study of traditional firms launching e-business initiatives.

Figure 2: Information Technology Infrastructure for e-Business



Adapted from P. Weill & M. Broadbent "Leveraging the New Infrastructure:
How Market Leaders Capitalize on IT" , Harvard Business School Press, June 1998, pp 37.

The time required to implement a new e-business initiative will depend in part on the firm's insourced and outsourced infrastructure capability. For example, in building a new web-based housing loan system, a large bank needed to use the following information technology infrastructure services: mainframe and server processing, customer databases, security procedures and systems, and both local area and national communications networks. Having those infrastructure services already in place significantly reduced the time and cost to build the loan system. However, the newly built system could not be released immediately, because firewall security services were not in place to support a web-based application that integrated customer data and credit scoring systems with the Internet customer interface. Direct customer access was not considered in the initial design of the infrastructure services. The firm had to postpone launching the new initiative until the security services were ready. If well designed, the new security infrastructure services will be re-used for many other web applications.

Where to place the IT infrastructure capability (e.g., firm-wide or in a business unit) is a strategic choice made by senior management (see Figure 2). For example, E-business often involves a single electronic point of contact to the firm by a customer. The firm's information technology infrastructure must then integrate information from separate business units so that the customer can obtain the desired business service from the chosen point of contact (see point B on Figure 2). Firms taking full advantage of a customer's transaction with one part of the business will attempt to cross-sell products and services from other parts of the business. Alternatively, the single point of contact could be made for only one business unit at point A in Figure 2, limiting the cross selling and information gathering possibilities to that business unit only. This positioning within the firm is a strategic issue for senior management.

Infrastructure capability is difficult to create because it is a fusion of technology and human assets.[ii] These capabilities have long lead times to emulate and can provide a source of competitive advantage. We know from our research that firms with greater infrastructure capability have faster times to market, higher growth rates, and more sales from new products, but lower short term profitability.[iii] Building an infrastructure tailored to a firm's strategic context takes considerable time and expertise. While the components are commodities, the management processes used to implement the best mix of infrastructure capabilities to suit a specific firm are a much scarcer resource.

Demands of E-Business on IT Infrastructure

Before gathering data from firms, we anticipated that e-business would bring about four types of change with in a firms' IT infrastructure: more capability, gravity, external, and cooperative[iv].

More capability: To compete successfully in an e-business world, IT infrastructure will continue to become more important, resulting in both a greater number of services and increased spending on these services over time.

Gravity: There will be a general trend towards providing infrastructure services on a firm-wide basis rather than at the business unit or departmental level. For reasons both of cost savings (from increased scale and reduced duplication) and of implementing strategic initiatives (e.g. single point of customer contact in a multi-business unit firms), infrastructure will experience gravity and drop from point A to point B on Figure 2. For example, Johnson and Johnson has recently announced all IT infrastructure previously provided independently by more than 175 business units will be centralized and managed on a firm-wide basis.[1]

Outsourcing: The rapid implementation demands of e-business will drive an increase in IT outsourcing, particularly for commodity and highly specialized services. As IT infrastructure services become better understood, many commodity services will be outsourced. Furthermore, as application service providers (ASPs) prosper and determine their pricing models, more infrastructure applications (e.g. shared and standard business processes and applications such as

[1] Conversation with Gregory J Poorten, Director, Product Lifecycle Management, Johnson & Johnson Networking & Computing Services, January 2001.

infrastructure applications (e.g. shared and standard business processes and applications such as HR, purchasing, and accounts payable) will be outsourced. We expect firms to insource the IT infrastructure that is important for their competitive advantage or core competencies (e.g. workflow, intranets, knowledge management) and outsource or at least market test commodity services.

Co-ooperative: Given the attractive economies and potential strategic control the owners of a single, dominant infrastructure have, we expect to see competitors and allies within industries share IT infrastructures. For example, automotive manufacturers are cooperating to compete with the announcement of joint ventures in managing supply chains. Ford, GM and DaimlerChrysler have combined forces to form a business-to-business integrated supplier exchange that will be the world's largest Internet-based virtual marketplace.[vi] The new enterprise will offer open participation to auto manufacturers around the world and to their suppliers and dealers as well. The three partners will have equal ownership in the business, which will operate independently from its parents. The President and Chief Operating Officer of General Motors, G. Richard Wagoner Jr., commented on the industry's efforts to build independent exchanges and the decision to work cooperatively in order to compete more effectively. "As we continued to build our separate exchange sites, we quickly realized traditional, individual, stand-alone models weren't the winning strategy for us, our industry, our suppliers and, ultimately our customers. By joining together we can further increase the pace of implementation... We are excited about the opportunity to build on what each of us started separately and create the best trading exchange in the world."

Study of Information Technology Infrastructure Needed for E-business

The purpose of our study was to identify and define the IT Infrastructure services relevant to particular atomic e-business models and their combinations, and to identify trends in infrastructure provision. We sought first to identify and categorize all the information technology services relevant for e-business, and then to identify statistically which services were more important for each e-business model.

We spoke to CIO's, senior IT infrastructure managers, information technology managers, IS planning managers, and E-commerce managers. We studied 50 e-business initiatives in a diverse range of Asia-Pacific subsidiaries of global firms, Australian-based global firms, and government agencies, including manufacturing, natural resources, financial services, postal, retail, and agricultural resource companies.[vii] The Appendix describes the study methodology in more detail.

Beginning with a list of 25 information technology infrastructure services from a 1997 study of IT infrastructure, we expanded the services needed to include those we believed, on the basis of discussions with several firms, were required for e-business.[viii] We then piloted and iteratively amended the list by gathering data from companies in questionnaire and interview format until a stable set of services emerged. The result was a list of 70 infrastructure services, categorized into the nine areas listed below. The figures in brackets are the number of services in each area. The Appendix provides detailed definitions of each infrastructure service area and a complete list of the 70 information technology infrastructure services with the percentage of firms providing each service and their relative investment level.

Areas of information technology infrastructure services

We grouped the 70 services into 9 areas:

Applications Management (13 services)
Communications Management (7)
Data Management (6)
IT Management (9)
Security (4)
Architecture and Standards (20)
Channel Management (7)
IT R&D (2)
Education (2)

Figure 3: IT Infrastructure Services for e-Business

	Is Service Provided?	Offered Firm Wide or Business Unit		Relative Investment	Sourcing			Service Used for			
Areas (Number of Services)	% HAVE	%FW	%BU	-10 (lowest) to +10 (highest)	%IN	%OUT	%BOTH	%B2B	%B2C	%BOTH	NON EC
1. Applications Infrastructure (13)	90	71	18	3.7	57	22	20	23	1	66	10
2. Communications (7)	81	71	11	3.7	26	45	30	26	2	67	5
3. Data Management (6)	78	63	15	4.8	54	21	25	17	1	77	5
4. IT Management (9)	91	80	11	3.8	50	23	26	14	1	84	1
5. Security (4)	100	93	7	6.1	51	8	41	15	0	85	0
6. Architecture and Standards (20)	95	91	4	2.7	79	0	21	7	0	93	0
7. Channel Management (7)	51	41	10	4.6	40	31	29	20	4	76	0
8. IT & Research and Development (2)	83	77	7	2.5	56	8	36	16	0	84	0
9. IT Education (2)	82	71	11	3.9	24	40	36	12	0	76	12

Figure 3 summarizes our findings on the extent of provision of these infrastructure services. Each row represents one of the areas of infrastructure service, with the number of services in parentheses. The numbers in the body of the table are the average firm responses for all the services within each area. The columns in Figure 3 are interpreted as follows:

The first column is the percentage of firms that provide the service. For example, there are six infrastructure services in the area of data management. On average, these services are provided by 78% of firms. The percentage of firms providing each service within each infrastructure area varies (see the Appendix). For example, 100% of firms managed key data independent of applications.

The second and third columns are the percentage of the firms studied that offer the services firm-wide or only to certain business units. For example, in the data management area, 63% of firms provide the services firm-wide, while 15% of firms provide them only to specific business units. The remaining 22% of firms do not provide these services centrally.

The column headed "Relative Investment" is an average of the firms' relative investment in each service area. In the interviews we asked managers whether there would be an increase or decrease in spending on each service in the next year (2001) to provide support to e-business initiatives. We asked managers to indicate this on a scale between –10 and + 10. A +10 indicates that, relative to other services, the percentage increase in investment in this service was the highest in the coming year. Conversely a –10 indicates that the service would receive the greatest relative disinvestment over the next year. A zero means no change in relative investment in that service.

The first of our anticipated effects (i.e., more capability) of e-business on IT infrastructure was strongly supported in two ways. Firstly, the increase (from 25 in 1997 to 70 in 2001) of the number of independent infrastructure services found in large firms indicates a significant increase in the complexity and variety of services offered. Secondly, all services except EDI had positive relative investment in 2001 compared with the previous year, indicating a blanket increase in spending on infrastructure.

The areas with the highest relative investment were security, followed by data management and channel management. Channel management provides the electronic channel (e.g. Web site, call centers, interactive voice response) to the customer or ally to support multiple applications. Channel management is a new category of infrastructure services developed as a result of e-business. Security was universally identified as critical to give customers and senior management alike, confidence in e-business activities. All four security services identified were provided in 100% of firms, and 93% of the firms provided them on a firm-wide basis.

The columns headed "Sourcing" present the percentage of firms providing the service areas using insourcing (%IN) outsourcing (%OUT) and a combination (%BOTH). The columns headed "Service used for" describes the percentage of firms using the service areas for: B2B e-business (%B2B), B2C (%B2C), both B2B and B2C (%BOTH), and not for e-business (%NON-EC).

About half of the IT infrastructure services in this study were sourced purely internally (48%), with 22% outsourced and 29% provisioned both internally and externally. This is a significant increase in outsourcing from the previous study, which found that over the five years from 1992—1997, just over 9% of IT infrastructure was outsourced, increasing at the rate of 10% a year. The increase in 2001 strongly supports our third anticipated effect of increased outsourcing in general as well as the move towards selective outsourcing. For example, there was a very high use of total outsourcing in the area of communications services (45% outsourced) but zero use of total outsourcing in the more strategic areas of architecture and standards. Instead of outsourcing these

services totally, firms either insourced the services or provided them cooperatively, often with the help of consultants and vendors.

Our final anticipated infrastructure trend was not well supported by this study. We found surprisingly few examples of cooperative infrastructure provision. Interestingly, five of the 50 e-business initiatives studied had a shared infrastructure component in the business model, all requiring shared IT infrastructure. Perhaps we are still in the beginning stage of this trend. Alternatively, we now believe, given the complexities of managing co-operative IT infrastructure, the trend may never eventuate. For example, when competitors such as the three major car manufacturers share IT infrastructure, the negotiations to determine which elements (particularly data) are shared and which are kept private must be very complex and time consuming. The litigation-laden history of the airline computer reservation systems provides strong evidence for the difficultly of implementing co-operative IT infrastructures.

One of the important roles of the IT group in a firm migrating to e-business is to identify the important IT services that are needed now and will be needed by the firm in the future. However, with 70 IT infrastructure services to potentially use for e-business, even the largest, most IT savvy firms cannot have them all. For many firms, providing all 70 services would be an irresponsible over-investment in IT infrastructure with little likelihood of generating a financial return. We propose that firms can use atomic e-business models to classify their e-business initiatives and thus understand in advance what IT infrastructure service are needed.

Atomic e-Business Models

We have identified eight atomic e-business models that can be combined in multiple ways to create new e-business models (see Figure 4).[ix] Each atomic e-business model describes the essence of a different way to conduct business electronically. Atomic e-business models are the building blocks for e-business initiatives. Understanding the characteristics of these atomic models allows us to analyze what is necessary to make them work in combination as an e-business initiative.

Figure 4: Atomic e-Business Models

Content Provider	Provides content (information, digital products, and services) via intermediaries.
Direct to Customer	Provides goods or services directly to the customer, often bypassing traditional channel members.
Full Service Provider	Provides a full range of services in one domain (e.g. financial, health) directly and via complementors, attempting to own the primary consumer relationship.
Intermediary	Brings together buyers and sellers by concentrating information.
Shared Infrastructure	Brings together multiple competitors to cooperate by sharing common IT infrastructure.
Value Net Integrator	Coordinates activities across the value net by gathering, synthesizing, and distributing information.
Virtual Community	Creates and facilitates an online community of people with a common interest enabling interaction and service provision.
Whole of Enterprise / Government	Provides a firm-wide single point of contact, consolidating all services provided by a large multi-unit organization.

Information Technology Infrastructures Needed for Each Atomic Model

To understand the IT infrastructure needs for each atomic model, we asked the CIO or the infrastructure manager to describe each of the major e-business initiatives in the firm. Later we analyzed each of the firm's initiatives identifying which one or more atomic e-business model was involved. On average, each initiative incorporated two atomic models and ranged from one to three atomic models. Then an analysis was conducted to determine which of the 70 services were statistically more important (i.e. more money spent) for each atomic model.[x] Generally five or six services were most important for each model, and the sets of services for each model were quite distinct. Figure 5 summarizes the critical infrastructure categories containing the statistically significantly important infrastructure services for each atomic business model. Other infrastructure services will be needed to implement each of the atomic models, but these services were the most important as determined by relative investment levels. For example, all atomic models use security services but in no model was it the most important area.

Figure 5: Summary of IT Infrastructure Focus for Atomic Models

Atomic e-Business Models	Application Infra.	Commun-ication	Data Mgt.	IT Mgt.	Security	Architecture & Stds	Channel Mgt.	IT R&D	IT Education
Number of Services	13	7	6	9	4	20	7	2	2
Content Provider		✓	✓	✓	✶	✓	✓		
Direct to Consumer	✓✓	✓	✓	✓✓	✶				
Full Service Provider	✓	✓	✓	✓	✶		✓	✓✓	
Intermediary	✓✓	✓	✓	✓✓	✶				
Shared Infrastructure					✶	✓✓			
Value Net Integrator	✓	✓	✓		✶	✓	✓✓		
Virtual Community	✓			✓✓	✶			✓	✓
Whole of Enterprise	✓✓	✓	✓✓	✓	✶			✓	

✓✓ = very important ✓ = important ✶ = required

We now address each model in turn, describing which IT infrastructure services were most important. Each service mentioned attracted statistically significantly higher investments by firms pursuing the particular model.

Direct to Customer

The *direct to customer* model requires significant investment and reliance on three areas of infrastructure service: application infrastructure, communications, and information technology management (see Figure 5). In the area of application infrastructure, implementing a *direct to customer* model requires investment in payment transaction processing (service 1-13), enterprise wide resource planning (ERP) (service 1-8), and workflow (service 1-12) infrastructure services. (The numbers in parentheses are the infrastructure services identified in the detailed tables in the Appendix.) These three services all relate to the task of automating and integrating the firm's systems—the EFT systems collect the funds and the ERP systems process the transactions. The workflow infrastructure is necessary to optimize business process performance. The *direct to customer* model often services many customers, who generate millions of transactions a month. ERPs are typically the transaction-processing engine for these firms, and any e-business initiative thus requires extensive investment in ERP integration, fine-tuning, and data management.

Three other infrastructure services were very important for the *direct to customer model*: communication network services (service 2-1) linking all points in the enterprise to each other and the outside world, often using the IP protocol; the installation and maintenance of workstations and local area networks (LAN's) –(service 4-3) supporting the large number of people required to operate a *direct to customer* model; and service level agreements (service 4-7) between the business and the information technology group or outsourcer to ensure, monitor, and improve the systems necessary for a *direct to customer* model.

Full Service Provider

The *full service provider* model requires significant integration between multiple business units within the firm and a series of third party providers, all packaged into a single offering to the customer. For many firms, achieving this level of integration requires a significant increase in the centralized management of information technology infrastructure capacity (service 1-6), including capacity management and tracking. This change has a technical component, moving from managing multiple systems, often on different platforms across multiple business units, to a centralized model integrating or linking multiple systems. The change also needs a more difficult cultural shift emphasizing and rewarding firm-wide needs and goals rather than those of the individual business units, requiring strong leadership and a different information technology governance structure.

The move to centralized governance and management of information technology also requires evaluating proposals for information technology initiatives (service 8-2) and identifying and testing new technologies for business purposes (service 8-1). A centralized service for proposal evaluations is required to coordinate information technology investment across a multi-business unit firm with the goal of single point of customer contact. The *full service provider* model is not workable if each business unit optimizes its own information technology needs. Providing electronic support to groups (service 2-7) was another important service to facilitate the cross-business unit teams needed for the model, which are supported by increased investment in the installation and maintenance of workstations and LANs (service 4-3). The move to a more centralized infrastructure necessary for the *full service provider* model is expensive in dollar terms and time consuming in organizational terms, requiring leadership, cooperation, and often a change in incentive schemes to reward firm-wide performance.

Whole of Enterprise

The *whole of enterprise* model also enables a single point of customer access to a multi-business unit organization, often organized by "life events" or topics of interest. Implementing this model effectively also requires centrally managed infrastructure capacity (service 1-6), and identifying and testing new technologies for business purposes (service 8-1). Implementing the *whole of enterprise* model doesn't usually require the high level of integration of applications and platforms of the *direct to customer* model. Instead the *whole of enterprise model* needs services that summarize data from the different applications and platforms to provide a firm-wide perspective. This firm-wide perspective is often achieved via the electronic provision of management information (service 3-4) and managing key data independent of applications (service 3-1), perhaps in a data warehouse or similar system. The *whole of enterprise model* also requires significant investment for transaction processing including: ERP (service 1-8), transaction payment processing

such as EFT to receive payment (service 1-13), and large-scale data processing (service 4-1) to reduce the cost of transactions.

Intermediary

Intermediaries generate value by concentrating information and bringing buyers and sellers together. Managing this highly information-intensive business requires infrastructure services that support knowledge management (service 3-6) such as knowledge databases and contact databases that enable the codification and sharing of knowledge. The *intermediary* e-business models, more than any of the other models, is fundamentally an electronic business trading in information about buyers and sellers. The products and services are all electronic and the business relies completely on information technology, investing heavily in workstation networks (2-5). *Intermediaries* also invest heavily in infrastructure services to manage and get value from information technology; including information systems planning (service 4-4) and information systems project management (4-5). As most of the communication with customers, suppliers, and allies is electronic, *intermediaries* invest heavily in workstation networks (2-5) and polices for the use of email and the Internet (services 1-3 and 1-1).

Shared Infrastructure

The *shared infrastructure* business model requires competitors to cooperate by sharing information technology infrastructure and information. This level of cooperation requires agreement on high-level information technology architectures as well as operational standards for applications, data communications, and technology (services area 6). Effective implementation of the *shared infrastructure* model also requires enforcement of these standards, and most *shared infrastructure* models have a joint committee to set and enforce the standards. Another role of these committees is to implement the policies of the *shared infrastructure* about what information, if any, is shared and what information is confidential to partner firms.

Virtual Community

The *virtual community* model brings together a group of members around a common interest. To maximize the effectiveness of the community, members should be well informed and educated on the use of the technology (service 9-1). Similar to the *intermediary*, the *virtual community* is an on-line business, and therefore invests heavily in information technology management infrastructure services including IS planning (service 4-4) and workstations and LANs (service 4-3). Many virtual communities outsource the information technology required to support the community to application service providers (service 1-11). Technology for supporting virtual communities is specialized, and the management of these communities often prefers to focus nurturing the community and designing the services rather than providing the technology platform. To keep their communities attractive and leading edge, managers of *virtual communities* invest heavily in the infrastructure service area of information technology research and development. This area includes both infrastructure services for identifying and testing new technologies (service 8-1) and for evaluating proposals for new information systems initiatives (service 8-2).

Value Net Integrator

The *value net integrator* succeeds in its role by gathering, synthesizing, and distributing information. To collect and analyze information from many sources, *value net integrators* need

centralized data warehousing in order to summarize data from decentralized databases (service 3-2). Heavy investment is also made in middleware to link systems on different platforms (1-9) and in telecommunications network services (2-1). To function, a *value net integrator* requires information technology infrastructure services that link different technology platforms owned by different firms. Achieving this integration requires high-level architectures to increase compatibility (service 6-17).

Content Provider

Content providers deal in large amounts of information including images, maps, and video, requiring significant investments in storage farm or storage area network infrastructure (service 3-5). *Content providers* require a strong focus on architecture, including setting and enforcing standards particularly for data, work, applications, and telecommunications. *Content providers*, like intermediaries, are fundamentally an online business and invest heavily in workstation network infrastructures (service 2-5). *Content providers* must excel at tailoring and manipulating the their core content to meet the specific needs of customers. *Content providers* of digital products must categorize and store their content in well-indexed modules so it can be customized to meet customer needs via a wide variety of channels. To provide compatible and integrated systems, *content providers* invest heavily in common systems development environments (service 4-8). Customers and transactions tend to be relatively few, at least compared with the number of end consumers and their transactions.

IT Governance is an Answer

Understanding which atomic e-business models are represented in the firm's anticipated e-business initiatives is a good place to start for IT groups providing IT infrastructure services. The firms we studied had an average of 3.3 major e-business initiatives underway. On average each e-business initiative involved two models. After eliminating a small amount of overlap, there were about 10 critical IT infrastructure services needed for the e-business initiatives in a firm. The critical question is how senior management can design a process to involve the IT group in e-business strategizing, both to get IT input to business strategy and to provide the IT group with an early warning of what infrastructure services will be critical. Such a process is part of *IT governance,* the overall approach taken by a firm to sharing decision rights about information technology and monitoring the performance of IT investments. We believe that IT governance is the appropriate framework for addressing this critical question and must be designed to encourage desirable behavior (e.g., autonomy, sharing, speed, standardization, unpleasant surprises, etc.). Only senior management can and should determine what is desirable behavior.

An example of the effective use of IT governance to link IT and the business is the process in place at Australia Post, the highly successful government-owned postal service in Australia. Moving well beyond letter mail, its sole remaining monopoly service, Australia Post has undertaken a number of imaginative e-business initiatives that leverage the organization's brand and physical infrastructure. For example, the "Pay It at Post" service allows Internet shoppers who do not have a credit card, or who do not want to give their credit card details over the Internet, to pay for Internet purchases at any of the 4,500 post offices around Australia. Electronic links from Australia Post notify Internet merchants that payment has been made, and the goods are shipped – perhaps to a post office, where buyers can pick up their purchases without having to be at home to accept delivery.

Australia Post has also formed an alliance with Coles Myer, Australia's largest retailer, to deliver groceries ordered over the Internet.

Ideas for e-business initiatives spring up frequently from across Australia Post, and from the many outside firms that seek to form alliances with the organization. Post's national manager of e-business, who has responsibility for guiding the development of e-business across the firm, assists in filtering and refining these ideas on the basis of viability and strategic fit. This is undertaken in conjunction with representatives from corporate strategy, financial management, and IT. A sponsor is sought for each of the remaining ideas, and a business case prepared. The surviving proposals are sent to the IT steering committee, of which the e-commerce manager is a member, which assesses the implications of each idea for IT infrastructure and staffing. Some ideas would place such a heavy burden on Post's resources that they go no further. The business cases go through the standard process used by Australia Post to approve IT investments, including Board approval for very large expenditures.

The Australia Post process thus puts business and IT together at a very early stage in the lifecycle of an e-business initiative. The IT steering committee, which is chaired by the Group Manager – Information Technology Planning, gets advance notice of the IT infrastructure requirements of proposed initiatives. By working closely with the e-business general manager, who reports directly to the Managing Director, IT can support the selection of e-business proposals. Because it uses the firm's standard processes for preparing business cases and approving IT investments, the Post process sends the message that the focus of e-business is business, even though the ideas themselves are new. IT thus serves as an effective enabler of success.

Contrast Australia Post with a large insurance company, whose e-business division operates completely independently of IT. The head of the division is in a different building from the CIO, and is openly disdainful of the company's IT unit. Individual business units across the firm undertake e-business initiatives, often without consulting IT or each other and generally bypassing standard investment approval processes on the grounds that e-business must not be constrained by "old economy" concepts. The IT group first hears about some of these initiatives when the necessary infrastructure is needed urgently, or when the strain on existing infrastructure has degraded performance for all users. It's little wonder that this large, information- intensive organization has made little progress with e-business despite substantial investments of money and time.

Senior management of existing organizations moving into e-business should examine their IT governance processes, and determine whether they encourage the necessary communication and control of e-business initiatives. An IT governance audit may be appropriate to assess the IT governance structure and behavior that it encourages. If implemented appropriately, the findings of such an audit would have benefits well outside the realm of e-business as well as increasing the return on e-business investments.

Appendix: IT Infrastructure Services

The Appendix contains definitions and detailed data regarding our study of IT infrastructure services and e-business. We gratefully acknowledge the time and cooperation of the participating firms and the work of Peter Raisbeck of the Melbourne Business School. We studied 50 e-business initiatives in 15 firms, all of them subsidiaries of global firms, Australian-based global firms, or government agencies. The table shows the atomic business models found in the e-business initiatives studied. The 50 e-business initiatives had a total of 89 occurrences of the atomic models, with *direct to customer* the most common. We conducted an analysis to identify the infrastructure services associated with each atomic business model. Brief descriptions of the nine areas of infrastructure services are provided, followed by a detailed table describing the 70 infrastructure services.

Atomic Models Represented

The atomic models were implemented in 50 e-business initiatives studied with the following frequencies:

ATOMIC MODEL	TOTAL
Content Provider	12
Direct to Customer	33
Full Service Provider	5
Intermediary	13
Shared Infrastructure	5
Value Net Integrator	14
Virtual Community	1
Whole of Enterprise / Government	6

Categories of IT Infrastructure Services

Applications Management

An "application" is a software program that resides on a computer for the purpose of translating electronic input into a meaningful form. Applications management includes purchasing software, developing proprietary applications, modifying applications, providing installation and technical support, and other tasks related to ensuring that applications are meeting the needs of the organization.

Communications Management

Communication management focuses on all technology that facilitates digital communication both within the organization and with the outside world. It includes the management of hardware and

software to facilitate communication via computer, telephone, facsimile, pagers, mobile phones, and other communication and messaging services. It includes the cabling and any other communication linkages required to create an effective communications network, in addition to the necessary hardware and applications to meet the needs of the organization.

Data Management
Data management refers to the way the organization structures and handles its information resources. Data may be sourced from internal or external databases. Data management includes data collection, database design, sorting and reporting information, creating links to external databases, assuring data compatibility, and other activities surrounding the effective management of electronic information.

IT Management
Information technology management includes many of the professional and strategic activities of the information technology group including negotiation, IS planning, project management, and other tasks. IS project management is defined as the coordination and control of all of the activities required to complete an information systems project.

Security
Security refers to the need to protect data, equipment, and processing time. Organizations restrict access to certain data and protect data and applications from manipulation or contamination. Recovery refers the need for a plan to maintain computer operations and information should a disaster occur.

Architecture and Standards
Information technology architecture[xi] is a set of policies and rules that govern the use of information technology and plot a migration path to the way business will be done in the future. In most firms it provides technical guidelines rather than rules for decision-making. Architecture has to cope with both business uncertainty and technological change, making it one of the most difficult tasks for a firm.[xii] A good architecture evolves over time and is documented and accessible to all managers in the firm. Each architecture decision needs a sound business base to encourage voluntary agreement and compliance across the business. A standard is a detailed definition of the technical choices to implement an architecture. Five elements of architectures and standards were studied: data, technology, communications, applications, and work. We also distinguished between specifying architecture or standards and enforcement.

Channel Management
Channel management recognizes that new and emerging technologies allow direct connections or distribution channels to customers. We were interested in finding out which electronic channels were important and how IT departments were managing the technologies supporting these channels.

IT Research and Development
The information systems market develops rapidly, particularly with the rise of new e-business technologies. It is thus necessary to continually test applications and hardware to assist with

planning decisions. IT research and development includes identifying and testing new technologies for business purposes and evaluating proposals for new information systems initiatives.

Training and Education in the Use of IT
We define training as formal classes, individual training, and technology-based self-training programs for users ensuring hands-on computer proficiency levels meeting corporate requirements. We define IS management education as education aimed at senior levels in the firm designed to generate value from IT use.

Detailed Table of Study Results

The following table presents the detailed data from the study of IT infrastructure services for e-business. The definitions and interpretation of the column of figures are:

The first column is the percentage of firms that provide the service in each area. There are thirteen infrastructure services in the area of applications infrastructure. The percentage of firms studied that provided each service is shown. For example, 86.7% of firms provided middleware linking applications on different platforms (service 1.9).

The column headed "Relative Investment" indicates the firm's relative investment in each service area. In the interviews we asked the senior managers to indicate, on a scale between –10 and + 10, whether their firm will increase or decrease spending on each service in the next year to provide support to e-business initiatives. A +10 indicates that, relative to other services, the increase in spending on this service would be the highest in the coming year. Conversely a –10 would indicate that the service would receive relative disinvestment over the next year. A zero means no change in relative spending on that service. The service that was highest on relative investment rating was "Centralized management of infrastructure capability" (service 1.6), followed by two security services (services 5.2 and 5.3).

APPENDIX

Information Technology Infrastructure Services and E-Commerce Survey Data

		% Have	Relative Investment
Applications Infrastructure		**89.8%**	**3.7**
1.1	**Internet policies** *(e.g. employee access,URL logging)*	100.0%	1.7
1.2	**Enforce internet policies**	93.3%	1.9
1.3	**Email policies** *(e.g. inappropriate and personal mail, harassment policies, filtering policies)*	100.0%	1.8
1.4	**Enforce email policies**	93.3%	1.9
1.5	**Centralized management of e-business applications** *(e.g. centralized e-business development, common standards and applicetions, single point of access, multimedia applications.)*	100.0%	4.5
1.6	**Centralized management of infrastructure capacity** *(i.e. server traffic)*	100.0%	7.3
1.7	**Integrated mobile computing applications** *(e.g. laptop dialup and ISP access for internal users)*	100.0%	4.2
1.8	**ERP services** *(is the service currently available? Which ERP?)*	92.3%	5.9
1.9	**Middleware linking systems on different platforms** *(i.e. integrating web "shopfronts" to SAP systems)*	86.7%	7.1
1.10	**Wireless applications** *(e.g. web applications for wireless devices)*	69.2%	3.0
1.11	**Application services provision** *(e.g. applications used by business units and centrally provided)*	75.0%	2.6
1.12	**Workflow applications** *(e.g. Lotus Notes)*	64.3%	2.7
1.13	**Payment transaction processing** *(e.g. EFT)*	92.9%	3.7

		% Have	Relative Investment
Communications		**81.3%**	**3.7**
2.1	**Communications network services** *(e.g. full Service TCP/IP networks linking all points within a business)*	100.0%	4.7
2.2	**Broadband communication services** *(e.g. higher bandwidth activities such as video)*	71.4%	2.4
2.3	**Intranet capabilities** *(e.g. an intranet to support a variety of applications including publishing, co. policies, directories, message boards, etc)*	100.0%	6.0
2.4	**Extranet capabilities** *(e.g. providing information and applications via TC/ICP protocols to a select group of customers and suppliers)*	93.3%	6.4
2.5	**Workstation networks** *(e.g. workstation networks, LANs and POS networks)*	100.0%	2.8
2.6	**EDI linkages to customers and suppliers**	84.6%	-0.1
2.7	**Electronic support to groups** *(e.g. Lotus Notes or other groupware)*	20.0%	2.0
Data Management		**78.0%**	**4.8**
3.1	**Manage key data independent of applications** *(e.g. centralized product data)*	100.0%	5.2
3.2	**A centralised data warehouse which summarises key information from decentralized databases**	86.7%	4.5
3.3	**Data management advice and consultancy**	69.2%	3.7
3.4	**Electronic provision of management information** *(e.g. EIS)*	71.4%	4.3
3.5	**Storage farms or storage area networks** *(e.g. major storage separate from LANS and workstations)*	86.7%	4.6
3.6	**Knowledge management** *(e.g. contact database, KM architecture, knowledge databases, communities of practice)*	53.8%	6.3

		% Have	Relative Investment
IT Management		**90.9%**	**3.8**
4.1	**Large scale data processing facilities** *(e.g. mainframe)*	92.9%	2.5
4.2	**Server farms** *(e.g. mail server, web servers and printer servers)*	100.0%	4.8
4.3	**Installation and maintenance of workstations and LAN's**	100.0%	3.2
4.4	**IS Planning** *(e.g. forward plans end strategy. What is the cycle time?)*	86.7%	3.3
4.5	**IS project management**	93.3%	3.4
4.6	**Negotiate with suppliers and outsourcers** *(e.g. centralised and negotiated pricing for software)*	100.0%	4.1
4.7	**Service level agreements** *(e.g. agreements between Corporate IT and BU's)*	80.0%	4.5
4.8	**Common systems development environment**	78.6%	2.5
4.9	**Pilot e-business initiatives** *(e.g. pilot web "shopfronts" managed in conjunction with BU's)*	86.7%	5.9
Security		**100.0%**	**6.1**
5.1	**Security policies for use of information systems** *(e.g. data protection, access privileges and hacker protection)*	100.0%	5.9
5.2	**Enforce security policies for information systems**	100.0%	6.1
5.3	**Disaster planning for business applications**	100.0%	6.5
5.4	**Firewall on secure gateway services**	100.0%	5.7

		% Have	Relative Investment
Architecture and Standards		**95.5%**	**2.7**
6.1	**Specify architectures (data)** *(set high level guidelines and blueprint for the way data will be used and integrated)*	92.9%	3.0
6.2	**Specify architectures (technology)** *(set high level guidelines and blueprint for the way technology will be used and integrated)*	100.0%	2.9
6.3	**Specify architectures (communications)** *(set high level guidelines and blueprint for the way communications technology will be used and integrated)*	100.0%	3.2
6.4	**Specify architectures (applications)** *(set high level guidelines and blueprint for the way information technology applications will be used and integrated)*	100.0%	3.5
6.5	**Specify architectures (work)** *(set high level guidelines and blueprint for the way work will be conducted)*	84.6%	2.5
6.6	**Enforce architectures (data)** *(enforce compliance with high level architectures)*	92.9%	2.9
6.7	**Enforce architectures (technology)** *(enforce compliance with high level technology architectures)*	100.0%	2.5
6.8	**Enforce architectures (communications)** *(enforce compliance with high level communications architectures)*	100.0%	2.8
6.9	**Enforce architectures (applications)** *(enforce compliance with high level applications architectures)*	100.0%	3.1
6.10	**Enforce architectures (work)** *(enforce compliance with high level work architectures)*	84.6%	2.5

		% Have	Relative Investment
Architecture and Standards cont...		**95.5%**	**2.7**
6.11	**Set standards for IT architectures (Data)** *(Set standard operating environment (SOE) to implement data architectures)*	92.9%	2.5
6.12	**Set standards for IT architectures (Technology)** *(Set SOE to implement technology architectures)*	100.0%	2.7
6.13	**Set standards for IT architectures (Communications)** *(Set SOE to implement communications architectures)*	100.0%	2.7
6.14	**Set standards for IT architectures (Applications)** *(Set SOE to implement applications architectures)*	100.0%	2.8
6.15	**Set standards for IT architectures (Work)** *(Set SOE to implement work architectures)*	84.6%	2.5
6.16	**Enforce standards for data architecture**	92.9%	2.2
6.17	**Enforce standards for technology architecture**	100.0%	2.2
6.18	**Enforce standards for communications architecture**	100.0%	2.3
6.19	**Enforce standards for applications architecture**	100.0%	2.5
6.20	**Enforce standards for work architecture**	84.6%	2.5

		% Have	Relative Investment
Channel Management: provide electronic channel to customer or partners to support multiple applications.		**51.3%**	**4.6**
7.1	**Eftpos/POS**	50.0%	5.7
7.2	**Kiosks**	30.0%	1.7
7.3	**Web sites**	100.0%	6.9
7.4	**Call centres**	85.7%	4.0
7.5	**IVRs**	33.3%	2.0
7.6	**Mobile phones**	30.0%	1.3
7.7	**Mobile computing** *(e.g. via dial up)*	30.0%	2.0
IT R&D		**83.3%**	**2.5**
8.1	**Identify and test new technologies for business purposes**	80.0%	2.3
8.2	**Evaluate proposals for new information systems initiatives**	86.7%	2.6
IT Education		**82.1%**	**3.9**
9.1	**Training and use of IT**	85.7%	3.9
9.2	**Management education for generating value from IT use**	78.6%	3.8

[i] For this section we draw heavily on M. Broadbent and P. Weill "Management by Maxim: How business and IT managers can create IT infrastructures," *Sloan Management Review*, Vol 38, No 3, Spring 1997, p. 77–92 and P.Weill and M. Broadbent, "Leveraging the New Infrastructure: How market leaders capitalize on information technology," (Boston, MA: Harvard Business School Press, 1998).

[ii] See J. Barney, "Firm resources and sustained competitive advantage," *Journal of Management* 17, no. 1 (1991): 99–120.

[iii] P. Weill and M. Broadbent, "Leveraging the New Infrastructure: How market leaders capitalize on information technology" (Boston, MA: Harvard Business School Press, 1998), p. 58–62.

[iv] The authors would like to acknowledge the contributions of Professor Lynne Markus of Claremont Graduate School and City University of Hong Kong as well as Nancy Wendt and Eileen Birge of the Concours Group to the ideas of this section.

[v] Conversation with Gregory J Poorten, Director, Product Lifecycle Management, Johnson & Johnson Networking & Computing Services, January 2001.

[vi] "Ford, General Motors and DaimlerChrysler Create Worlds Largest Internet-Based Virtual Market Place" Press Release February 25, 2000 – www.generalmotors.com. Both quotes from Jack Nasser and G. Richard Wagoner, Jr. are part of the press release.

[vii] The authors would like to acknowledge Peter Raisbeck, a Senior Research Fellow at the Melbourne Business School who worked with us to collect and analyze the data.

[viii] The starting point was the list of 25 infrastructure services in Figure 4–2 on page 88 and the eight clusters of infrastructure services in Figure 5.3 on page 119 of M. Broadbent and P. Weill. "Management by Maxim: How business and IT managers can create IT infrastructures," Sloan Management Review, Vol 38, No 3, Spring 1997, p. 77–92. The ninth category of infrastructure services "channel management" was added to include the ability of the firm to support a direct electronic connection to the customer via a variety of channels.

[ix] "Place to Space: Migrating to e-Business Models" by Peter Weill and Michael Vitale, Harvard Business School Press 2001, page 21.

[x] A bivariate correlation analysis between the list of 70 services and the 8 atomic models was performed using a single tailed test with a probability of significance (alpha) of 0.1 or smaller suitable for an exploratory analysis. All services described in the next section were statistically significant. Where more than six services are listed they were all statistically significant.

[xi] For two excellent discussions of information technology architecture see, P.G.W. Keen," Every Manager's Guide to Information Technology," 2nd ed. (Boston, MA: Harvard Business School Press, 1995); M. J. Earl, "Management Strategies for Information Technology" (London: Prentice-Hall, 1989).

[xii] To reach this description of information technology architecture we have drawn on the written work of, and discussions with, a number of people. We would like to acknowledge Peter Keen, Margrethe Olson, Michael Earl, Stewart Neimann and B. Robertson-Dunn.